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AN ENQUIRY INTO THE MOVING POWERS Employed in the Circulation of the Blood;

IN A

LECTURE

Delivered at NEWCASTLE, the 28th of December, 1773,

To a large Company of Gentlemen of the Faculty, and others.

By ANDREW WILSON, M. D.
Fellow of the Royal College of Phyſicians at Edinburgh.

> Eſt enim animorum ingeniorumque naturale quoddam quaſi pabulum, conſideratio, contemplatioq; naturæ. Erigimur, elatiores fieri videmur, cogitantes ſupera atque cœleſtia. Indagatio rerum tum maximarum, tum etiam occultiſſimarum habet oblectationem. Si vero aliquid occurret, quod veriſimile videatur, humaniſſima completur animus voluptate. CICERO *in Lucullo.*

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1608/5057.

TO

Sir John Huſſey Delaval, Bart.

SIR,

YOUR character, and what I have the honour to know of your taſte and favour for uſeful reſearches, either in Arts or Sciences, make me ambitious of inſcribing this ſmall treatiſe to you. I beg you will do me the honour to accept it as a teſtimony of the reſpect and eſteem with which

I am,

SIR,

Your moſt obedient,

And moſt humble ſervant,

A. WILSON.

AN

ENQUIRY, &c.

THE great populouſneſs of this place and of its neighbourhood, with the number of conſiderable towns ſurrounding it—the number, conſequently, of perſons that muſt be employed in and bred to the practice of medicine in this populous department—the neceſſary length of apprenticeſhips here in particular, which obliges youth to continue all that time in a great meaſure uninformed of the fundamental inſtitutions of the practice of medicine—the remoteneſs of other places, after a long ſeven years ſervitude, to which they muſt reſort for the completing of their inſtructions and education, and at the ſame time the difficulty and inability that many labour under to ſupport the unavoidable expence that attends a further improvement of their knowledge.—Theſe conſiderations, collated with the exiſtence of a large infirmary here, as well inſtituted and ſupported, and as well furniſhed with phyſicians and ſurgeons, who ſhould be qualified to be maſters in their profeſſions, as any in the kingdom out of London, ſo ſtrongly and ſelfevidently point out this place as a proper theatre both for the cultivation of medical ſcience among the gentlemen of that profeſſion themſelves, and for the eſtabliſhment of ſome plan for the inſtruction of youth therein, that I have converſed with few upon that ſubject, who have not expreſſed their ſurprize at that want of ſpirit for improvement, that has left all theſe circumſtances ſo long unattended to, and totally neglected.

I have heard it alſo obſerved with equal ſurprize, that in a place ſo populous—ſo opulent—ſo open to all kinds of correſpondences—ſo well furniſhed with all means for proſecuting improvements in either arts or ſciences, and in ſhort, where, of conſequence, ſo many perſons of intelligence, inquiſitive and deſirous of improvement in every kind of knowledge, might be ſuppoſed to be—that in ſuch a place no ſociety or aſſociation of any kind was ever attempted to be formed, for the advancement of knowledge, or as a rational and uſeful entertainment for perſons addicted to improvement in either the arts or ſciences.

Some have pleaded in excuſe, the want of a reſpectable, that is, as I ſuppoſe they mean a wealthy, patronage, to give ſpirit and encouragement to ſuch attempts. But the apology I think is a very lame one. For as knowledge is not only the moſt valuable, but likewiſe the moſt inde-

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pendent acquiſition that human nature can attain, and what the greateſt affluence can neither command nor convey; it is debaſing it to ſuppoſe, that the true ſpirit of it ſhould, like a barometer, riſe and fall according to the influence of wealth upon it.

Theſe conſiderations, and the diſpoſition that I know ſome perſons of reſpectable abilities and education have to countenance and promote ſuch attempts, have encouraged me to preſent my hearers with the following intereſting diſquiſition,—to ſhew, by way of incitement to ſuch enquiries and diſcuſſions, how imperfect ſtill the ſtate of knowledge is upon ſubjects we are apt to think moſt fully elucidated already, and how great room there is ſtill for diſcovery and improvement, wherever we turn ourſelves.—If my diſcourſe ſhould have the good fortune to be adopted or rather admitted as a preliminary to either of the inſtitutions above-hinted at, I ſhall account myſelf very happy, and very much honoured. If it ſhould happen otherwiſe, I ſtill can be no loſer; for the reſearch itſelf is not a matter of nicety and curioſity only, but of no ſmall conſequence and importance to the profeſſion of medicine.

PREVIOUS to my engaging with the enquiry into the moving powers moſt immediately and neceſſarily concerned in the circulation of the blood, which I propoſe as the ſubject of this diſcourſe, it may be requiſite that I preſent ſuch of my hearers, as may be in any meaſure ſtrangers to the ſubject, with as clear and plain an idea as I can convey to them, without terms of art, of the general ſtructure and actions of the heart.

I need ſcarcely do more than tell you, that a muſcle is a compoſition of animal fibres that have a power of contracting and conſequently of moving themſelves, and whatever is connected with them; and that the heart is ſuch a muſcle, or rather collection of muſcles. —The arteries are theſe veſſels that carry the blood from the heart to all the parts of the body, dividing conſtantly off from one another, like the branches of a tree, till they terminate in the greateſt conceivable tenuity.—The veins which bring the humours back again from every part of the body, begin in the ſame attenuated ſtate as the arteries ended in, and as they unite, they enlarge, till they meet in one great trunk or vein, which brings the blood back to the heart.—The heart itſelf conſiſts of four chambers, or rather of two pairs of chambers, an outer and an inner one.—Each of theſe chambers is to be conſidered as a diſtinct muſcle, or muſcular bag, which has a power of contracting itſelf ſeparately.—Into the outer chamber of the right ſide, or more properly the fore ſide, of the heart, the great vein I mentioned called the Vena Cava, opens and pours in the blood. When that outer chamber, commonly called the right auricle, is full, it contracts by its muſcular force and empties itſelf into the inner chamber, called the right ventricle; which, when it is filled, alſo cantracts and injects its contents into an artery called the pulmonary artery, which by its diviſions and attenuations ſheds the blood through the whole ſubſtance of the lungs.

In the ſecond pair of chambers of the heart the like proceſs is tranſacted over again. The incipient and imbibing veins take in all the blood diffuſed through the lungs by the arteries, and uniting their forces as they meet, terminate all at laſt in one great vein, called the pulmonary vein, which unloads itſelf into the outer chamber of the ſecond pair of rooms, called the left auricle of the heart, which, when filled, contracts and iſſues its contents into the inner chamber, called the left ventricle of the heart, which when it is full, contracts alſo, and diſcharges itſelf into the great artery, called the Aorta; which branching off, and ſeparating into infinite ſubdiviſions, both in regard to their number and tenuity, diffuſe the blood in form or in ſubſtance to every organ and ſpot in the animal ſyſtem.—I need only obſerve further to you, in order to your diſtinctly conceiving the actions of the heart above ſpecified, that, each chamber is furniſhed with a complete ſet of valves, which, when the chambers contract themſelves, exactly ſhut and preclude any of the blood from being forced back again by the way that it entered.

From this hiſtorical account of the perpetual tranſactions of the heart, you muſt diſtinctly perceive, that in the ſubſequent diſcourſe I do not pretend to diſprove it is by the action and force of the contractions of the heart that the blood is thrown out of it into the arteries: But, that theſe actions have little or no concern in ſupporting the progreſs of the blood along the finer arteries, after it is thrown into the great one, and ſtill leſs, in having any ſenſible influence on its motion through the veins back again to the heart.

THE circulation of the blood, as above-deſcribed, was no ſooner aſcertained by the celebrated and learned Dr Harvey, than the force and energy of the muſcular contractions of the heart was firſt univerſally ſuppoſed, and then admitted and acquieſced in almoſt implicitly, as the only conſiderable moving cauſe of the whole: And this, with few variations or additions, continues to conſtitute the ſum of the doctrine of the circulation, from the æra of Dr Harvey down to the preſent time.—The nature of this diſcourſe does not preſcribe to me the entering into any minute ſearch or detail of all that has been ſuggeſted or ſaid upon the powers of circulation. I ſhall take notice of ſuch particulars as I know, or as occur to me, in the courſe of this diſcourſe; and if any other author before me, that I may either have not ſeen, or not attended to, has advanced what I may imagine peculiar to my ſentiments and reaſoning in this diſquiſition, I can content myſelf with the genuine uncopied originality of my own reflections, without contending for the honour of priority with ſuch perſons[*].

By the vigorous contraction of the heart, and the elaſtic or muſcular reaction of the throbbing arteries, then, together with that ſpecies of lateral reſiſtance, from the atmoſphere without us, and what acts as an equivalent to it within us, (without which indeed all motion would languiſh and fail) the blood is ſuppoſed to be urged on to the fineſt filaments of the arteries and glands; and not only ſo, but to be propelled into the incipient veins, which, uniting their ſtreams, unite alſo their forces in bringing the blood back to the heart again.—As a ſupplement to theſe powers, the late ingenious and learned Dr Whytt ſuggeſted, with ſome reaſon, the perpetual oſcillations of the finer veſſels, ſqueezing the blood forward in the direction of its progreſs*:—and to the aſſiſtance of the motion of the venous ſtreams of blood, is alſo ſuggeſted the attraction of capillary tubes, by which liquors are diſpoſed to riſe in them to certain heights, and alſo the motion of the muſcles everywhere when they act, preſſing the veſſels.

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[*] Since this diſcourſe was delivered to the printer I have ſeen, in a liſt of foreign publications, a treatiſe in Italian expreſsly upon the ſame ſubject, publiſhed at Modena.

The firſt ſuppoſition I ſhall ſpeak to by and by; but that laſt is ſo incidental, and the progreſs of the circulation is in ſo many inſtances equally perſiſting when every muſcle is at reſt, that little weight can be allowed to that as a neceſſary and permanent cauſe.

But notwithſtanding all the auxiliary ſupplements that may have been occaſionally ſuggeſted, as conſpiring in ſupport of the circulation, ſtill the force and momentum given the blood's motion by the muſcular contractions of the heart, has been eſteemed of ſuch importance, and ſo ſufficient for the weight of the charge, that the moſt celebrated calculators, ſuch as Borelli, Sir I. Newton, Keil, Jurin, Hales, Haller, &c. have engaged in the niceſt experiments and calculations to aſcertain with preciſion, the force of the muſcular contractions of the heart,—the quantity of the blood thrown into the arteries by each ſyſtole,—the force and velocity with which the blood is propelled into the arteries, &c.

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* That there is a perpetual motion of the animal fibres everywhere, while natural heat remains in the body, ſomewhat analogous to the vermicular motion of the inteſtines, is pretty certain. It would ſeem to be maintained principally, by the conſtant elapſe, wandering, and reabſorption of warm active effluvia everywhere; and by the perpetual action of the nerves or ultimate fibres, as after explained, everywhere.

Indeed the fact of the heart's contractions, and the expulſion of the blood out of its cavities thereby, is ſo certain, and the ſuppoſition of its power for accompliſhing all that is inferred from it, has the appearance of being ſo ſimple, ſo mechanical, and ſo natural; that it is no great wonder that the ſubject has hitherto eſcaped a ſtricter and more accurate examination. What eſcapes the moſt penetrating genius's, may ſometimes be ſtumbled upon by very ordinary capacities; which ought to be conſidered as an encouragement to every man's induſtry, let his genius be ever ſo ordinary.

Now the intention of this diſquiſition, which I have undertaken, is to prove, that the force impreſſed upon the blood by the heart, is not the power which conveys it to the extremities, makes it penetrate every pore and filament of our frame, and from theſe ſubtle transfuſions recollects it, and returns again, what does return of it, to the heart. This I ſhall endeavour to do by a demonſtration of the following propoſitions: 1. The heart is not the fountain or origin of the motion of the animal fluids. 2. The blood in paſſing through the heart, and being ſubjected to its impreſſions acquires no quantity of motion that it was not poſſeſſed of before. 3. That the arterial motion of the fluids does not depend neceſſarily on the impulſes of the heart, but can be accompliſhed independent of any ſuch force. 4. The mechanical force or momentum of the heart's contractions is abſolutely inſufficient to propel the blood to the extent of the arterial circulations and ſecretions. 5. There are, in fact, other powerful agents always ſubſiſting in the animal frame, which, by a mechanical neceſſity, muſt act in promoting the progreſſive motion of the blood, more immediately than the heart can do, and where the powers of the heart cannot reach. 6. There are, beſides theſe, influences preſiding in the animal ſyſtem which can be reduced to no mechanical ſtandard, but, at the ſame time, without which all the intricate mechaniſm in our frame, juſt and unerring as it is, would not be ſufficient to ſupport one revolution, nay nor one moment's progreſſion of our fluids. To theſe, by way of corollary, I ſhall add, 7. That both the primary and final intention of the agency of the heart in the animal œconomy, muſt be ſomething very different from, and leſs obvious than, the ſupporting of the progreſſive motion of the blood.

FIRST PROPOSITION.

Firſt then, I ſay, that the heart is neither the original ſeat of the motion of the animal fluids, nor the original cauſe of their motion. It is ſelf-evident, I apprehend, that we muſt look for the primary cauſe and powers of the motion of our fluids in the organs, which are conſtantly employed in taking in the ſtocks of freſh ſupplies, which the repairs of our conſtitution, and the ſupport of its motions require. Here we are neceſſarily referred to the abſorption of the chyle, or of our digeſted aliments. The pulſations of the heart, or the momentum of its contractions, cannot reach the chyle in the firſt paſſages, and drive it into the lacteal veſſels; and theſe veſſels, as abſorbents, having no pretence to communication with arteries, can partake of no aſſiſtance from them, in taking up the chyle, and tranſmitting it to the blood. Now the lacteals are a venous ſyſtem of veſſels, and the chyle's motion in them is entirely venous; that is, it is a concurrent motion, where the veſſels and the ſtreams that flow in them, are always uniting and enlarging*. How much

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* Some may imagine, that the diſcharge of the chyle by the lacteal duct into the left ſubclavian vein, is of ſmall conſequence in eſtimating the powers which move the fluids; but they are much miſtaken: For, as in a ſound habit the repairs of nouriſhment muſt be equal to the waſte, ſo the power with which theſe repairs are introduced into the blood muſt be equal to the circulating powers concerned in the diſcharges of perſpiration, urine, and the animal parts of the feces taken conjunctly.

much it is the characteriſtic of all venous ſyſtems of veſſels to act as abſorbents, we ſhall proceed to conſider.

2. In the lymphatics. The diſcovery of the ſource of the lymphatic ſtreams, has been of late thought a matter of ſo much conſequence in phyſiology, as to have been very keenly diſputed between two eminent anatomiſts: So that we may venture to take it upon the evidence of their experiments, that the lymphatics are alſo a ſyſtem of abſorbent veſſels gathering up extravaſated fluids, wandering out of the reach of the heart and arteries, among the interſtices of the veſſels. Theſe then, namely, the lacteals and lymphatics, are two ſtreams in the animal ſyſtem, that are not only perpetually flowing, but alſo perpetually ſupporting the motion of the other vaſcular fluids, independent of the direct impreſſions of the heart.

3. The abſorption of the lymphatics appears to me ſo inconſiderable, when compared with that of the proper veins everywhere in our ſyſtem, that, if the lymphatics are not deſtined for a particular ſpecies of abſorption, which I am inclined to ſuppoſe, I can conſider them as no more than as proviſional auxiliaries to the veins in that office.

When we maturely conſider the immenſe power of abſorption in the ſkin, and not of it only, but of every ſurface within the body, as is every day documented in the practice of phyſic, in the applications of poultices, fomentations, embrocations, frictions, fumigations, and injections of various kinds, one would be tempted to infer, that the veins almoſt wholly terminated in abſorbents.

But there is ſtill greater reaſon for the preſumption, if we reflect alſo what a very large proportion of the animal fluids are always in an extravaſated ſtate. If we conſider that the immenſely largeſt proportion of the vaſcular ſyſtem is of that attenuated kind, which the fineſt injections cannot reach ; and at the ſame time, if we attend that the exterior ſurfaces of all theſe veſſels are conſtantly in as moiſt and ſucculent a ſtate as their cavities, we will ſee ſtrong reaſons to ſuſpect, that, though ſome of the arteries may paſs into continuous veins, yet the groſs of them muſt be terminated in imbibing orifices, and conſequently that the circulation muſt, in ſtrict propriety, be carried on by the medium of extravaſation and reabſorption, incomparably more than by any uniform continuation of arteries into veins.

It is not my intention in this diſcourſe to enter minutely into an inveſtigation of the phyſical cauſe of abſorption ; but in ſo far as it appears of ſuch importance in maintaining the circulation of the blood, I muſt beſtow a reflection or two upon it. Firſt, then, it is generally, for explication, referred to that power by which fluids are ſaid to aſcend in capillary tubes. That the power exerted in every kind of attraction or ſuction may be the ſame with that which cauſes liquors riſe in capillary tubes, I make no doubt; but ſtill, as the two motions are very diſſimilar in leading circumſtances, the aſcent of liquors in capillary tubes, as illuſtrated by common experiments, is a very unſatisfactory illuſtration of venous ſuction: For, in the firſt caſe, the tubes muſt be in an empty ſtate when fluids riſe into them; and then, the fluids do not continue to riſe in capillary tubes, but become ſtagnant at certain heights.

In venous abſorption, on the contrary, the fluids continue aſcending and penetrating into veſſels that are full, and likewiſe, they continue advancing progreſſively, without ſtagnating or becoming arreſted in their motion, at any height or diſtance from the orifices of the imbibing veſſels.

Hence, ſecondly, we muſt infer, that though all the veſſels in the animal compoſition are full from one end to another, yet there muſt be a waſte or vacuum conſtantly going on at one extremity of the veſſels, in order to give place and make room for what is imbibed by the oppoſite extremities of the veſſels. Liquors muſt ceaſe to riſe in any veſſel or veſſels that are full without waſte. Therefore upon this ſubject it muſt, I think, be concluded, that the conſtant waſte and inanitions happening in the animal frame are the immediate, though in another ſenſe, the remote cauſe of its capacity for conſtantly aſſuming freſh ſupplies into the veſſels.

What that power is, or theſe powers are, which diſſipate the materials of our conſtitution, I ſhall have occaſion to conſider more particularly by and by; but whatever they are, we muſt view that power of attraction which brings the chyle into vaſcular motion, in an inſeparable connection with them.

By ſurveying the actions of our frame in this point of view, ye muſt perceive, Gentlemen, that the venous and arterial circulations become indiſpenſibly tied together, and united in their reciprocal influence upon each other's motions, ſo as the one muſt always neceſſarily imply the other.

I make this obſervation here, becauſe it may be objected, that though a venous or confluent circulation may not require the impreſſions of the heart to perpetuate it, yet an arterial or dividing circulation neceſſarily does. But I ſay, that if an arterial circulation can be conſidered as neceſſarily inſtrumental in the production of a venous circulation, which has no dependance on the impulſes of the heart; then the power of the heart, which in our conſtitutions lies between theſe two extremes, cannot be ſuppoſed eſſentially neceſſarily to an arterial circulation, whoſe influence reaches to a circulation where the heart as a muſcle is not at all concerned. Hence it is inferred a priori, that of whatever importance the modification of the circulation at the heart may be in the conſtruction of animals, yet the heart cannot be ſaid to be eſſentially and abſolutely neceſſary to the circulation of our fluids.

SECOND PROPOSITION.

The ſecond propoſition I have undertaken to demonſtrate is, that the blood, in being ſubjected to the contractions of the ventricles of the heart, acquires no quantity of motion that it was not poſſeſſed of before.

The heart does not act upon the blood as a pump does upon ſtagnant water, putting it into a motion and courſe that it had not before. This ſimile is not a correct one; for in fact the principal, though leaſt obſerved action of the heart, is its power as an exhauſter, which I ſhall conſider anon: but at preſent I allude to its poſitive force in throwing the blood into the arteries. In this reſpect, I ſay, it is not like a pump acting on ſtanding water. In fact, the blood was poſſeſſed of as much motion in the veins when it arrived at the heart, as the heart communicates to it in diſcharging it into the arteries. So that the interpoſition of the heart's agency in giving motion to the blood, cannot be ſuppoſed abſolutely neceſſary to its progreſs in the arteries, unleſs it could be proved that the momentum, with which the blood is diſcharged from the vena cava, was inſufficient to preſerve its courſe in the arteries, without the additional aſſiſtance of the heart's contractions. But it is abſurd to ſuppoſe this, if it can be proved, that the momentum of the blood in the vena cava is as great as the momentum of the blood thrown into the aorta by the heart.

The heart tranſmits by its contractions no blood into the arteries but what it receives from the veins; therefore it cannot deliver it either faſter or with greater momentum than it receives it: Therefore, again, the momentum of the blood in the veins is equally ſufficient, as the contractions of the ventricles of the heart, to ſupport the motion of the blood in the arteries. Nay more, I ſay, that the abſolute momentum of the blood moving in the vena cava, and conſequently in all the veins, is greater than the momentum with which it moves in the aorta, and conſequently in all the arteries: For though the heart can deliver no blood to the arteries, but what it receives from the veins, yet the veins really receive as much reſiſtance to the freedom of the motion of the blood in them, by every contraction of the auricles of the heart, as the arterial blood receives acceſſion of momentum by the contractions of the ventricles; excepting in ſo far as the muſcular vigour of the auricles and ventricles may differ from each other.

I know that appearances may be pleaded againſt me, and that it may be alledged that an artery of the ſame dimenſions bleeds with much greater fierceneſs than a vein does. But in the firſt place, it may be replied, that there is no making a comparative eſtimate between arteries and veins in this reſpect, on account of the different thickneſs of their coats, on account of the uncertainty of the contiguous anaſtomoſes, and likewiſe on account of the different ſtate of the elaſtic vapour of the blood in arteries and in veins. But, all circumſtances ſuppoſed parallel, and allowing the fact to be true, the velocity with which a fluid flows out of an orifice is no proof of its degree of velocity in its veſſels, but is rather a proof of its progreſſive motion not being proportioned in velocity to the power with which it is urged. There is a great difference between being preſſed with greater force, eſpecially alternately in the percuſſive manner, and moving progreſſively with greater momentum. The firſt I allow in the caſe of the arterial blood, but the laſt, I deny.

THIRD PROPOSITION.

Having proved under the laſt propoſition that the motions of the heart add nothing to the momentum of the circulation; that the force of the blood iſſuing out of the veins is as ſufficient as the force of the heart to ſupport an arterial circulation, and that the venous and arterial circulations are connected together, in the relation of cauſe and effect, by links that are independent on the power of the heart's ſyſtoles; I come now to prove the truth of the ſame doctrine by examples, that arterial motions of fluids can be ſupported, and are in fact conſtantly celebrated without the neceſſity of the heart's actions, or the interpoſition of ſuch a forcer in the center between a venous and an arterial circulation.

Becauſe in the particular diſpoſition of our frame, the heart is known to occupy this ſtation, and to preſide at the orifices of the great arteries, therefore, by I know not what diverſion of our attention, or deception of appearances, it has always been taken for granted, that there was a mechanical neceſſity for the action of the heart there, and that without it the momentum of the blood in the cava could not have been ſufficient to have diſtributed and divided it in the arteries, through ſuch an infinite number of ramifications, and in ſuch an inconceivable variety of directions, produced by the angles, flexures, and involutions of the veſſels, as they divide and decreaſe. Though perhaps all motion, ſtrictly ſpeaking, is both impreſſed and continued by preſſure; yet there are certain motions, ſuch as the running of water, the aſcent of vapour and the like,

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that having no ſenſible appearance of any reſiſtance to their tendency, may in an improper and vulgar ſenſe be termed ſpontaneous; and ſuch I take the motion of the fluids both in the veins and in the arteries to be.

The firſt example I ſhall adduce of this kind of arterial motion, which is ſupported without any ſuch impulſes as are analogous to the ſhocks of the heart upon the blood, is the circulation or progreſſive motion of the ſap in vegetables. In them the fluids aſcend of their own accord, as we expreſs it, to the remoteſt branches, leaves, and fruit of the loftieſt trees.

It implies no objection to my argument to alledge, that in plants the caſe is not parallel, as in their transfuſion of fluids there is no direct or regular tranſition of arteries into veins. But what then, ſtill the example is concluſive for what it is adduced to prove; namely, that in their ſyſtem of circulation, the veins or roots of the plant act by abſorption only, and without the aſſiſtance of any vegetable mechaniſm analogous to the functions of the heart, transfuſe their juices to the fineſt and remoteſt fibres of the plant, which are its ſyſtem of arteries.

Again, to come directly to the point, we have in the particular œconomy of the liver a document of that very ſpecies of circulation, without the intervention of any pulſatory action, which has been ſuppoſed neceſſary to give venous blood an arterial direction and momentum. Though the liver is one of the moſt maſſy and compactly formed viſcera in the whole animal compoſition, yet the venous blood gathered from all the internal parts of the lower abdomen, entering it, immediately changes its confluent courſe. The end of the vein entering a particular part of the liver, called by anatomiſts the portæ or gates, reſolves itſelf into an artery, divides into branches, and ſpreads its ramifications through the whole ſubſtance of the liver, where, after furniſhing the ſecretion of the bile, the blood has a ſecond time its courſe reverſed into a venous one, recollecting it from the extremities of this ſingular artery, and bringing it back to the general conflux of the blood in the vena cava before it reaches the heart. In this inſtitution of animal circulation in the liver, the heart can have no immediate concern more than the kidnies, or any other particular organ in the conſtitution. Therefore we juſtly conclude that the heart occupies its ſtation not as a *ſine quo non*, or indiſpenſable organ in the circulating of animal fluids.

Nay more, in the regulation of the circulation in fœtuſes or unborn infants, the Author of Nature has ſhewed us, that at the heart itſelf, nature, the miniſter of his power, can manage the circulation even there in a great meaſure, without the heart's aſſiſtance. For, leaſt the lungs of infants, upon their firſt coming into the world, ſhould be either ſo over-grown, or ſo over-charged with blood as to reſiſt the impreſſions of the firſt breath of life ruſhing into them by inſpiration, the better half of the blood diſcharged in born perſons into the heart by the vena cava, is in unborn infants conveyed by a canal provided for the purpoſe, ſtraight into the aorta or great artery without being ſubjected to the impreſſions of the heart at all. So that this moiety proceeds in its courſe along the aorta, &c. without the aſſiſtance of the heart's action. Nor can it be ſuppoſed that this moiety of blood owes its after progreſs in its arterial courſe to the ſtrokes of the heart on the other moiety that paſſes through the lungs: The heart's power being only ſufficient for the quantity it acts upon.

As the ſubject of the fœtus ſuggeſts it, I cannot omit juſt noticing alſo a conſideration, which properly belongs to the confirmation of the firſt propoſition, namely, the ſupply of a venous circulation by ſuction, without the neceſſity of ſuppoſing veins to be either ſolely or chiefly a continuation of arteries. The nature of the communication between the unborn infant and the mother ſignally demonſtrates, that the ſupply of a venous circulation by ſuction ſeems pretty univerſally to be nature's eſtabliſhed or favourite mode.

FOURTH PROPOSITION.

The fourth propoſition I ſhall endeavour to prove is, that the muſcular power of the heart is not of force ſufficient to impreſs that momentum upon the fluids as to carry them to the ultimate limits of the circulation. I never addicted myſelf much to theſe branches of phyſiology, which depend upon nice algebraical calculations, therefore I will reſt my concluſions here upon ſuch general principles as will ſufficiently anſwer my purpoſe. For the argument's ſake then, I ſhall, in the firſt place, admit that the muſcular force of the heart is as great as any perſon upon calculation has ſuppoſed it to amount to.

If the progreſs of the circulation in the arteries depended upon the mechanical force with which the heart threw the blood into them, may it not be aſked, What then is the reaſon that no ſyringe can be invented that can be made to drive the ſubtleſt and moſt ſearching liquor half ſo far, nor into one-tenth of the number (I take a definite for an indefinite here) of the veſſels that the heart reaches and fills by its injections? If it is replied, that this is owing to the different circumſtances that both ſolids and fluids are in, while ſubjected to the impreſſions of the heart's power, from theſe the dead ſubject is under, when artificially injected.

I grant that it not only may be ſo, but that it certainly is ſo: But then it alſo certainly follows, that theſe circumſtances, and not the heart's force only, are the cauſe of the ſucceſs of its injections reaching the fineſt and remoteſt filaments and excretories in the animal ſyſtem.

There are powers in nature, which can inſinuate and drive moiſture, both into veſſels and the interſtices of bodies, ſo as to overcome an inconceivable reſiſtance to its progreſs. By ſuch means the hardeſt twiſted ropes may be ſhortened with ſuch power as to move immenſe weights faſtened to them; and the roots of trees have been known to open fiſſures in very maſſy rocks which reſiſted their growth and diſtenſion. But in ſuch caſes, any power driving ſuch fluids, analogous to the contractions of the heart in the animal ſyſtem, would prove of as little effect almoſt in the promoting of ſuch motion, as the fannings of a fly's wings. The caſe is nearly ſimilar in regard to an infinite number of the compact filaments and ſtrainers through which the animal fluids have to make their way.

Again, if we conſider the nature of the fluid, I mean the blood, ſuppoſed to be ſo ſyringed by muſcular force, through ſuch a complicated ſeries of meanders and involutions in the ſlendereſt and almoſt inviſible veſſels, we ſhall find it the unfitteſt liquor that can be imagined to be driven in its courſe by main force; for it muſt be a force not only ſufficient to urge a permeable liquor (which yet is impoſſible) but it muſt be a force ſufficient to grind down the viſcid glutinous tenacity of the blood, and break down the unequal ſizes of the particles of its conſtituent parts. That all this can be done by the main force of the contractions of the heart is ſo impoſſible, and ſo palpably ſo, that it never could have been thought of, but through the greateſt inattention.

If it ſhall be alledged or pleaded, that the momentum of the heart is not ſuppoſed to be concerned in attenuating the blood, and changing it into the ſubtlety requiſite for paſſing the fineſt canals and emunctories in its courſe,—I ſhall accept of the conceſſion, without making any ſtrict enquiry, whether many phyſiologiſts, by their mode of reaſoning and explaining themſelves, have given ſufficient cauſe for the imputation or not. But if it is allowed, that it is not the momentum given to the blood by the heart that reſolves it in the courſe of the circulation; then it follows, that there muſt be ſome other active power in our frame, which can change the ſtructure and tenacity of our fluids at will; and this implies, that that power which changes the blood, when the force of the heart cannot do it, muſt alſo be the power which moves the fluids, where they are ſo changed by it. For where they muſt be changed, there they muſt have ſtuck if they had not been changed.

In ſhort, every conſideration conſpires to evince, that the power of moving the fluids, where they are changed or aſſimilated to the nature of the parts they arrive at, and the power that aſſimilates muſt be one and the ſame: and what moves by that principle muſt move ſpontaneouſly, that is, without any occaſion for the application or aſſiſtance of that power we apply the idea of downright mechanical force to. There does not appear to be in our conſtitution any of theſe ſtrainings and filtrations, that have often been ſuppoſed in phyſiology. Our fluids are digeſted in ſuch a wonderful manner, and at the ſame time the various organs are ſo wonderfully adapted to them, that whenever they arrive within the influence of each other, the fluids inſtantaneouſly reſolve, or are metamorphoſed, and diſpoſed into a motion conformed to the ſtructure of the organ. They move, to uſe the ſimile, as iron does when it is ſaid to be attracted by the loadſtone.

I beg leave to touch upon another conſideration relative to this propoſition, before I diſmiſs it. It is another miſtake of inattention, and not a ſmall one in my opinion, which phyſiological calculators have ſtumbled into in their computations. They have always ſuppoſed that the heart contracts with the utmoſt muſcular force it is capable of exerting;

than which, in my opinion, there cannot be a greater miſtake. No muſcle can be either always, or the half of always in the exertion of its utmoſt muſcular vigour and power. This in a very ſhort time would overſet the whole equilibrium of our ſyſtem. The ſtrength of a man's muſcles may be able, by way of eſſay, to lift and ſupport for ſome time, by their utmoſt tenſion, an hundred or we ſhall ſuppoſe two hundred weight. But if all his life was beſtowed in ſuch an exertion, it would become a very ſhort one. Reaction will always be equal to action, and this law infallibly holds true in our ſyſtem, as well as in all other caſes. Every violent action has a violent effect, which muſt affect the whole conſtitution. The energy of the ſmalleſt muſcle exerted every moment, or every other moment, would throw all our other animal functions out of that poiſe that is eſſential to life. A muſcle acting perpetually or momentarily at the utmoſt ſtretch of its force, would become to the conſtitution like the power of the ſpring or weight in a piece of clock work without a regulator or pendulum.

I am not ignorant that muſcles without antagoniſts are ſaid to be always in a ſtate of contraction, without any of that hazard I apprehend. But no natural involuntary contraction is ever violent or extreme. The contractions of ſuch muſcles are a ſtate of eaſe and not of force; it is a gentle play,

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and not a violent labour; and ſuch muſt the action of the heart be. Therefore the blood cannot require theſe violent efforts to force it into its courſe. It muſt go almoſt ſpontaneouſly, as a ball thrown gently down hill, or that is humoured, ſo to phraſe it, in its tendency.

In fact, I think there is much reaſon to preſume, that all the quantity of motion the blood actually receives from the heart is exhauſted in the extenſion of the vibrating arteries. The reſt of its progreſſive motion we ſhall, as we have hitherto done, call ſpontaneous, until we can diſcover what other powers exiſting in the ſyſtem, preſide over and regulate its courſe; which brings me to the

FIFTH PROPOSITION

I propoſe to confirm; that, namely, there are other powerful agents always acting in the animal frame, which by a mechanical neceſſity influence the progreſſive motion of the blood, as well where the powers of the heart can be traced, as where they cannot poſſibly reach. All arterial circulation terminates either in evacuation, transfuſion, or accretion. As accretion cannot be ſuppoſed to be performed by the action of the heart upon the fluids, but by that power which diſpoſes ſimilar ſubſtances to coaleſce, whenever the quantity of that tendency is greater between them, than the tendency of ſuch particles to ſeparate motion; there is no occaſion for being more particular on this article. We ſhall therefore proceed to conſider evacuation, transfuſion depending upon it.

The evacuations of the circulating fluids, then, are performed either without the body, that is from the ſurface of the body, to which the common air has acceſs; or within the ſurface of the body. The laſt, namely, the evacuations within the ſurface of the body, are either drained off by glandular ſecretion, or accidental eſcape of humidity into all the interſtices and exterior ſurfaces of every veſſel and fibre. Theſe then I would have you to conſider, Gentlemen, as the leading circumſtances which not only give direction to the motion of the fluids, but which actively ſollicit them in their courſe, as I ſhall ſhew more particularly by and by.

Let us next conſider what are theſe requiſites in the fluids themſelves, which diſpoſe them to what I ſhall be well enough underſtood in calling *ſelf-motion*. The firſt requiſite then is, that a fluid be endowed with an evaporable degree of heat: Such a degree as diſpoſes it to preſs towards a colder place and ſtate, and to fly off in vapour wherever it can eſcape or get vent. This quality the blood is poſſeſſed of in a very remarkable degree. It diſcovers more vapour or volatile effluvia in it, than any liquor of the ſame degree of tenacious viſcidity that we know would do, under an equal degree of heat.

The ſecond requiſite is, ſuch a mixture and compoſition of principles in the fluid as diſpoſes it to that peculiar kind of inteſtine motion, called fermentation, by which the liquor expands itſelf, runs into new combinations and generates new principles. Thus, by fermentation, ſpirituous liquors are generated out of ſaccharine ones, and acids are generated out of ſpirituous liquors, or ſuch as might become ſo: And out of animal liquors, allowed to run into the ſame kind of inteſtine motion, are generated fœtid and volatile ſpirits. Now there is a double tendency of this fermentable kind always exiſting in the blood; the vegetable part of our chyle or concocted food is, by this inteſtine proceſs, always aſſimilating into the animal nature, and the animalized parts of our fluids are ſo diſpoſed to that fermentation which terminates in putrefaction, that nothing could preſerve them from it, but the directing of its niſus from that tendency, into a progreſſive motion.

The third active principle in liquors diſpoſing them to ſelf-motion is, the tendency in all liquors diſpoſed to ferment, to generate and extricate very volatile elaſtic effluvia of particular kinds, now commonly, though perhaps improperly, called *fixed air:* and this, moſt probably, is one cauſe of the re-

remarkable abundance of elaſtic vapour, which I obſerved already was ſo copious in the blood.

Whenever vents are opened to liquors ſtrongly diſpoſed to ſelf-motion, by any or all of the above circumſtances, thither its whole niſus muſt be intended. A familiar and ſtriking inſtance of this we have in liquors put into bottles, and corked before their fermentation is finiſhed. We all know with what violence they will not only diſcharge the corks which confine them out of the bottles, but throw themſelves out of them in *Jet d'Eaus*.

It is one of the manifold ſtrokes of infinite penetration and ſagacity diſcovered in the regulation of our fabric, that the innate diſpoſition in our fluids, ariſing from their commixture, to degenerate from their animal ſtate, ſhould continue ſo long to be exactly ſo far and no further exerted, as to determine our fluids by its niſus into progreſſive motion; and that, at the ſame time, this very progreſſive motion ſhould prove that very critical check which reſtrains the niſus to putrefaction in animal fluids, from advancing any further towards a pernicious change.

The firſt ſeries of paſſages, above mentioned, prepared for the progreſſive courſe of the blood diſpoſed for motion, as juſt now deſcribed, are the pores of the ſkin; which are of three kinds. The terminations of arteries, the excretories of theſe glands immediately under the ſkin, commonly called the ſebaceous glands, and the accidental, we may call them vents, through the intertexture and agglutination of the veſſels of the ſkin, which give paſſage to ſuch portions of the extravaſated effluvia as approach theſe orifices.

All liquors, which, from their attenuation, warmth, and divided ſtate, are evaporable, have a tendency to fly off into a cooler and leſs confined region, and to recede from that degree of warmth which volatiliſes them, whenever they can. This courſe they take wherever the air has acceſs to them, as on the ſurface of the body, the lungs, &c. Upon the ſame principle, the particles next in ſucceſſion to theſe that have eſcaped, take their place, and thoſe immediately behind them again occupy theirs: And ſo the ſame principle has its influence backward to the very riſe and ſource not of the arterial circulation only, but to the remoteſt venous abſorption alſo.

This, I apprehend, is nearly what is performed in vegetable circulation; and this power, in common with vegetables, we have conſtantly exerting itſelf in promoting our circulation. But though we have this power in a degree as much more active in us, as our fluids are warmer and more evaporable than theirs; yet it is far from all that is ſufficient to accompliſh all the intricaſies in the motions and ſecretions of the animal fluids.

Though it may be queſtioned whether there is in the compaſs of nature ſuch a thing as a ſtrict and proper vacuum, yet we certainly find everywhere ſuch vacua as anſwer all the purpoſes of abſolute ones, by not only giving free acceſs to the motion of groſſer and more conſiſtent bodies in them, but by really giving the motion of all ſuch bodies a direction and tendency towards them. Whatever is the mechanical cauſe of this, I have no occaſion to enquire into it juſt now: It is ſufficient for my purpoſe at preſent, that this matter may be depended on as a fact. Wherever then there is the ſecretory or excretory duct of a gland, there, or in the courſe of the liquor ſecreted from that gland, there is to be found ſuch a vacuum as neceſſarily influences the courſe of the humours arriving at it: As neceſſarily it does ſo, as a cupping glaſs either ſwells the part or draws the blood into it, where it is applied.

Let us illuſtrate this by an example where this influence is moſt obvious. In each of the kidneys there is a cavity, called the pelvis, into which all the ſecretory veſſels of theſe glands open: Of courſe, when that cavity is empty, thither will the liquor in the ſecreting veſſels flow, and thither will all the liquors in the veſſels communicating with the ſecretories ſtrain their motion and tend. If theſe cavities, called the pelves, had no vent from them, whenever they were full, the tendency of more liquor into them would be at an end, and the circulation in the kidney would ſtop of courſe; except in ſo far as the regurgitation might be relieved by abſorbent veins. But there is a long canal opens into the pelvis of each kidney, and runs from that down into the bladder. By emptying the bladder there is a comparative vacuum made, equivalent to the ſize and quantity of the urine it contained before it was emptied. I call it a comparative vacuum, becauſe the room of the full bladder, when emptied, is occupied only by the elaſtic effluvia contained in the inteſtines preſſing the lower abdominal parts into the vacuum made by the diſcharge of the urine. So of courſe, the bladder becomes as neceſſary and effectual a drain from the pelves, or cavities of the kidneys, as theſe are to the kidneys themſelves.

The caſe is preciſely the ſame, though perhaps not ſo obviouſly ſo, with regard to every gland in the body; each has its ſecretory either more immediately or more remotely ſucked by the influence of ſome one comparative vacuum or another. I ſay, ſucked, not becauſe of the phyſical propriety of the term, but becauſe it emphatically expreſſes the agency that, I would have you conceive, theſe vacua have upon the fluids contained in veſſels that they correſpond with.

By what means of the ſame kind there is carried on a conſtant extravaſation of effluvia, which bedews and keeps plump and ſucculent all the parts of the body, exterior to the veſſels and fibres everywhere, will be beſt underſtood by my explaining the important vacua, by which the venous flux of the blood is immediately affected and preſerved.

Ever ſince the aſcertaining of the circulation of the blood, that is for above theſe hundred years paſt, phyſicians have treated the momentum of the heart's contractions throwing the blood into the arteries, as a ſubject of the greateſt attention and importance both in phyſiology and in the practice of medicine: But none that I know of has beſtowed that attention that is due to the eſſential part the heart acts in the promoting of the venous circulation, not by its impulſes, but by its depletions: yet nothing can be more abſurd than to ſuppoſe the one, or more inattentive than to neglect the other. The ſole ſupport and preſervation of a venous current of blood to the heart depends upon a vacuum being momentarily provided where the veins ſhall unload themſelves.

I have ſhewn already in the mode of circulation inſtituted at the liver, that the impelling pulſations of the heart are not of eſſential neceſſity either to its arterial or its venous circulation. But in the mode of circulation eſtabliſhed at the heart, its evacuations, or its alternate ſtates of emptineſs become indiſpenſably neçeſſary to the whole ſyſtem of the venous circulation. Let us only examine this point with ſome attention and more circumſtantially.

When the veins are all full, and the auricles, or chambers into which the veins empty themſelves, are full alſo: Where is the collected ſtream in the veins to go next? There is no room for more in the auricle: What muſt be done? Why, the auricle contracts and empties itſelf. What is the conſequence? Why, a ſudden vacuum, equal to what the auricle could contain; the turgid veins ruſh their contents into the auricle to fill up the vacuum again, and all behind moving in the venous direction advances ſo much forward, with ſo much force, that the veins near the heart ſuſtain a pulſation from the regurgitation of this impetuous ſtream, when the auricle ſhuts upon it to empty itſelf. In ſhort, the full auricle occupies a determinate quantity of room in the breaſt: When it is emptied, there is a non-reſiſting vacuum of ſo much ſpace as was full before, and thither there is a mechanical niſus from the remoteſt filament of a vein over the whole body, which becomes conſpicuous in the torrent that ruſhes every other moment from the mouth of the vena cava into this vacuum.

Thus not only the continuous veins, ſuch as there may be, but every humid interſtice and extravaſated effluvia within the ſurface of the body, is ſucked, attracted, or impelled, call it what you pleaſe, as it offers into the direction of the venous ſtreams. All this is ſo mechanically neceſſary and conſequential, that I cannot help repeating my ſurprize that it has ſo long remained unaſcertained. But here I muſt not omit doing juſtice to the great Haller, who ſeems to have conceived ſome idea of the influence of vacuums on the circulation, when he ſpecifies a *vis derivationis quæ ſanguinem a ſede majis compreſſa ad ſedem laxiorem et minus reſiſtentem ducit*. Which power of derivation, he ſays, is not ſufficiently known yet*.

SIXTH PROPOSITION.

Notwithſtanding all the completeneſs of mechanical proviſions we find eſtabliſhed for ſecuring the circulation, yet they can be conſidered as no more than auxiliaries or acceſſories, ſeeing the motions of the animal ſyſtem could not be kept in play one moment by them all, without the preſidency and uninterrupted influence of a power, which I will not ſay is unmechanical, but which we cannot reduce either to mechanical rules or ideas. I mean that active principle exiſting every where in the ſyſtem of animals, which I call *life*. I do not mean that immaterial immortal part in us, whoſe concerns are more elevated and permanent than the regulation and ſupport of a temporary material automaton. I mean that ſupreme principle of natural life, which exiſts in every point of our frame, and diſſeminates its univerſal vitality in the irradiations of ſenſations, affections, volitions, &c. of every kind.

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* This ſentence of Haller's I cite upon the authority of another, for I could not diſcover it in that edition of his Prima Linea I am poſſeſſed of.

The ſtructure of our brain and its nerves, obliges us to conſider this eſſential principle, at the ſame time that it is exiſtent and in conſtant activity every where, as a real glandular ſecretion. Therefore, in its private office, the conſtant flux of this vital principle from the head to every point of our frame, muſt be conſidered as eſſential to the perpetuating of the circulation in the head, as the ſecretions of other glands are to the maintenance of the circulation in them. Yet what is truly wonderful of this ſecretion, and may with propriety be propoſed as a paradox, or phænomenon of the moſt difficult ſolution; it is a ſecretion without a waſte, or without any conſumption of the ſtock from which it is drawn*: And this renders the mode of the circulation in the brain different in its circumſtances from all other parts of the body, the heart, the liver, or any where elſe; becauſe, as I apprehend, the blood which goes into the brain by the arteries is all returned undiminiſhed back again by the veins: So that we cannot have at leaſt that direct recourſe to the influence of a vacuum there, that we have in ſolving the phænomena of the circulation in other glands. But at the ſame time that perpetual efflux conſtantly ſtreaming off from the nerves, and animating every particle and fibre by its energy, muſt have a powerful influence on the circulation of the animal fluids, through the ſubſtance of the brain, both as a director and as a motive power. This I call the private office of this ſecretion.

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* Thus it is that electrics *per ſe* are ſuppoſed to draw their electrical fire from non-electrical bodies, and to iſſue it always longitudinally into whatever direction the conductor is bent or twiſted; tho', if ſolicited by the approach of any non-electric, it is ready to burſt out ſide-ways at any part of the length of the conductor. This obviates another difficulty in regard to the motion of the vital principle along the nerves; if it is ſo ſubtile as to penetrate their ſubſtance in all directions, how can it hold its courſe according to their lengths, and diſcharge its influence regularly where they terminate?

That the nerves alſo ſhed their influence univerſally and intimately to every part and receſs of our ſubſtance, is, I think, what no one doubts; though few have reflected that it muſt, by a neceſſary conſequence, produce active vital effects, both upon the motions and diſpoſitions of the fluids in every part. I undertake to aſcertain this fact by an argument, which, if it ſhould be thought new, will not, I hope, be rejected merely on that account, if, upon weighing, it proves concluſive.

Nothing can be more certain and undoubted, than that the ſenſes, paſſions, and volitions have not only a moſt powerful, but in many inſtances a moſt inſtantaneous and moſt ſenſible effect upon the motions of our fluids; in ſome caſes, throwing immediate colour and heat into particular parts of the body, and in others, throwing the whole frame into a colourleſs rigour, and ſpreading a languor over all the motions of the fluids: In ſome inſtances, filling the whole machinery with an inſtantaneous lightneſs and vivacity in all its motion; in others, as ſuddenly oppreſſing and in a great degree choaking all the vital powers. Now can it be ſuppoſed that that vital principle, diſtinct from all that we know of the mechanical compoſition of our frame, adjuſted for maintaining the complicated motions of our fluids, could effect its motions ſo inſtantaneouſly, if it was not always preſent, and indiſpenſably acceſſary to them at all times. In ſhort, it proves, that that very principle, which is conſtantly blazing in us in living ſenſations and paſſions, is as inceſſantly employed in promoting and regulating every living movement of our fluids in every part. It could not act as it does in ſuch inſtances as I have hinted at, unleſs it was acting always.

It has always appeared very ſtrange to me, that many have been ſo curious in eſtimating all the mechanical circumſtances they could conjecture to themſelves, that might conſpire in the circulation, and in calculating their powers; as if any ſatisfactory ſum total of the moving powers could be aſcertained upon ſuch principles. In what we call mechanical, mechanics do all; but in a living machine they do nothing. It is life immediately and directly that does all; and mechaniſm is no more than a ſubordinate arrangement, ſeconding its operation, and a channel for life to move in. What in phyſics are called the powers or laws of nature, are not more fundamentally eſſential to mechanics, than what I call *life* is to them in the animal ſyſtem. In the human frame, life occupies the known properties and tendencies of matter by means of mechanics; but no mechanics can be conceived by the human capacity which can perform what the living principle does. Yet phyſiologiſts often reaſon and diſcuſs their ſubject, as if life was the effect of mechanics, inſtead of conſidering them as only the tract in which life moves, and the foot-ſtool of its powers.

The exertion and powers of the nervous ſyſtem, acting uninterruptedly, and diffuſing their virtue conſtantly in the ſame directions with theſe in which the animal fluids move, muſt efficaciouſly promote their progreſs. Beſides that animated vital character which the effluxes of that ſyſtem ſuperadd to the warmth and chemical commixture of the animal principles, in every ſolid and in every fluid particle of our frame, it inſtantly inverts, changes the arrangement, and diſpoſes the habit of each moving particle, ſo as to become entirely metamorphoſed, and inveſted with the particular character of the particular part where it either flows, is ſecreted, or accreſſes.

If we advert that life is but another name for ſelf-activity, and conſequently that the very eſſence of life lies in that activity, it is impoſſible but that the fluids in which that life reſides, as much as in the ſolids, muſt enjoy activity as a principle of their conſtitution, and not yield to motion by mechanical impulſes only, like inert paſſive maſſes. So active is this principle in us, that we cannot call our ſenſations or perceptions themſelves more vivid than it is in every part. Indeed our ſenſations themſelves are not any thing elſe than copies tranſmitted to our faculty of perception, of the inſtantaneous activity of this principle reſiding in the ſolids and fluids which compoſe every organ of ſenſe, in receiving, and variouſly modulating itſelf to every impreſſion that the courſe of nature without us can poſſibly make upon theſe organs.

But to drop the abſtracted diſcuſſions that this branch of phyſiology ſuggeſts, and to be brief. It is this principle of life, that gives that facility and momentum to the univerſal circulation of the animal fluids, which deſerves the name of ſpontaniety; without which, all the injectings and mechanical contrivances in nature could not open the receſſes of the vaſcular ſyſtem, and render them pervious to the moſt ſearching and penetrating fluids. It is this inherent, or rather conſtantly influent principle, that renders all, both ſolids and fluids, ſo active, ſo vigorous, ſo conſiſtent; and at the ſame time ſo placid, ſo obedient, and ſo permable, infinitely beyond the reach of merely mechanical impreſſions. In ſhort, it is this, and not the diameters of veſſels, the angles at which they divide, their elongations, flexures, or involutions, that renders all ſo lubricious, ſo various; and yet upon every change and ſecretion, ſo characteriſtic, and ſo conſiſtent. This work is not performed by the ſtubborn, robuſt agency of grinding, or dividing, by ſeparations and percolations, ſtrainings and ſqueezings of refractory combinations and commixtures of heterogeneous fluids: But every moving active particle of the fluids is preſently, and without one protracting reniſus, tranſmuted into the nature and habit which the organ it arrives at diſpoſes it to aſſume. This living temper and warmth oſcillates in every ſolid fibre, and fans the fire of nature in every fluid particle that approaches them: While theſe again return the quickening vibration to every ſolid, and diffuſe it reciprocally among themſelves.

SEVENTH PROPOSITION.

From what I have, I hope, proved, it neceſſarily follows, that both the primary and the final intention of the pulſation of the heart in the animal œconomy, muſt tend to ſome purpoſes diſtinct from the neceſſary ſupport of the progreſſive motion of the fluids. I ſhall beſtow a few reflections on what ſome of theſe purpoſes may be.

Firſt, then, it muſt be attended to, that the alternate pulſations of the heart neceſſarily imply a correſpondent alternation of the effluxes, or powers of the nervous ſyſtem, and of their origin the brain; at leaſt in ſo far as their powers immediately reſpect the action of the heart.

Phyſiologiſts generally ſuppoſe that the chambers of the heart, namely, the auricles and ventricles of the heart, are in a paralytic ſtate during the time of their diaſtoles, or during the time they are filling again with blood, after they have emptied themſelves by their ſyſtoles or contractions. It is alſo now ſuppoſed by ſome ingenious phyſiologiſts, that the heart is conſtantly rouzed out of this paralytic ſtate, by the irritation of the blood that fills theſe cavities from time to time. But this theory wholly reſts upon the ſuppoſition, that the relaxed ſtate of theſe muſcles is owing to ſome peculiarity in their ſtructure, by which they cannot preſerve their muſcular contraction above an inſtant at a time, and that they cannot recover it but by the reiterated action of a ſtimulus upon them.

Now all this is ſo contrary to the nature and tendency of muſcular fibres, and all that we know of them in other caſes, that the ſuppoſition ought not to be admitted upon leſs than a demonſtration, that it cannot be explained upon other principles more agreeable to the animal œconomy. We have inſtances of the natural contractile power of muſcular fibres being relaxed by irritation, as happens to both the ſphincters of the principal excretories in the body when they are ſollicited to a diſcharge: But I do not remember one inſtance of muſcular fibres whoſe natural contraction depends on irritation, excepting the circular fibres of the iris. No ſound muſcle can be in a relaxed paralytic ſtate, except from a defect of the influence of the nerves which communicate with it upon it. Hence it follows, that the intermiſſions of muſcular action in the heart, muſt proceed from an intermiſſion in the action of the brain and nerves upon it. There muſt be eſtabliſhed intermiſſions there of the effluxes from theſe organs of life upon the heart, which determine its alternate ſtates of action and inaction.

Therefore before phyſiologiſts take upon them to determine the uſe of the contractions and relaxations of the heart, it becomes a neceſſary previous enquiry, to diſcover what may be the uſe of theſe intermiſſions in the vital organs where they originate; becauſe poſſibly the importance of theſe alterternations there may be greater than in the heart, where they appear more ſenſibly, though only as an effect. I cannot propoſe here to enter more minutely into this diſquiſition: I ſhall therefore diſmiſs it with this reflection. Seeing reaction muſt always be equal to action, and as no effect can be greater than its cauſe, therefore the alternate efforts of the brain on the nerves that agitate the heart, muſt have as great an effect on the brain itſelf and its effluxes, as it has ſecondarily on the heart itſelf and the fluids whoſe courſe it regulates.

Secondly, there is good reaſon and ground to ſuppoſe, that the concuſſions of the heart have alſo a direct effect forward, upon the ſyſtem of the ſolids in which the fluids agitated by the heart move. I do not mean merely that paſſive expanſion and pulſation which it cauſes in the arteries, though I include it; but that every ſhock of the heart excites a reciprocal orgaſmus, or active tenſion, through the whole ſeries of the ſolids, which keeps them always prepared and enlivened for admitting and acting upon the fluids every where, in the manner I have attempted above to expreſs my conception of*.

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* There is ſome reaſon to queſtion whether the mere mechanical force with which the blood is thrown into the arteries, is the direct and only cauſe of the force wherewith the arteries vibrate. I have ſeen an aneuriſm in the arm that would have moved more pounds of weight than the artery either above it or below it, if I gueſſed aright, could move ounces. How that momentum was generated there, I leave to the reflexions of attentive phyſiologiſts.

Whether the arterial and venous ſyſtems connected with the ventricles and auricles of the heart by tendinous-like beginnings, act as antagoniſts to the muſcular contraction, I ſhall ſubmit to the deciſion of further enquiry and obſervation.

Thirdly, that the contractions of the heart alſo momentarily irritate and rouſe that vital principle animating every fluid particle, I have no doubt. But in order to comprehend fully the influence of the heart's contractions upon the fluids immediately paſſing through it, the circumſtances and qualities of the blood brought by the veins to the heart muſt be conſidered.

We are not, I have intimated already, to conſider any part of the vaſcular ſyſtem as a congeries of merely paſſive canals for the fluids. The importance of the veins, diſtinct from that of their being canals, has not been duly conſidered. Their office conſiſts of two parts.

Firſt, that of thoroughly animalizing the recent chyle, which has undergone only an arterial courſe. It is evident from the ſecretion of milk, that ſome of the fineſt filtrations of arterial circulation remain ſtill aſceſſant: But the veins complete the change, and render all the fluids in them perfectly animal, and of conſequence, they muſt exalt the animal nature of ſuch of the fluids as paſs through them a ſecond or a third time.

The ſecond branch of the office of the veins is, to elaborate the fluids into that form and compoſition which we know by the name of red blood. That this is the peculiar province of the veins is ſelf-evident, I apprehend: For though there may be accidentally a continuation of ſome arteries containing red blood into veins, yet it is certain there cannot be a continuation of ſuch a quantity as to ſupply the twentieth part of the red blood found in the larger veins. It muſt therefore be concocted by the veins out of the finer fluids they receive by abſorption or otherwiſe. In ſhort, the ultimate office of the arteries is to reſolve the blood into the various animal fluids and ſecretions; and, the buſineſs of the veins is to combine and regenerate them again into red blood; for the arteries generate none, they only receive it already compoſed.

The blood, then, in the vena cava aſcendens, is not only perfectly animal itſelf, but it receives an acceſſion of blood from the liver, which is ſtill more highly animalized, having undergone a complete courſe of both arterial and venous circulation a ſecond time; by which it becomes ſo highly exalted as to tend to diſſolution not only itſelf, but to affect the reſt of the blood with the ſame diſpoſition, if it was to perform its courſe through the heart and arteries again without the ſuppliment of freſh materials taken into the ſtock, which moderate its tendency, and furniſh it with qualifying combinations, or mixtures.

On the other hand, though the blood of the *vena cava deſcendens* muſt be as perfectly animal as that in the *aſcendens*, yet its nature is no leſs diluted and let down, by the conſtant acceſſion of freſh chyle poured into the left ſubclavian vein, than the blood of the cava aſcendens is exalted, by the acceſſion of the hepatic blood.

Theſe two then guſh into the firſt chamber or right auricle of the heart; there they are confounded, and undergo firſt the conquaſſation of the auricle throwing it into the ventricle, and then the conquaſſation of the ventricle intimately mixing the two differently diſpoſed liquors, and throwing the compound out by the pulmonary artery, through the whole ſubſtance of the lungs, even into, I had almoſt ſaid poſitive, contact with the air we inſpire.

The great and important intention of this courſe of the blood through the lungs is in order to engroſs another ingredient, namely a portion of freſh common air, at each inſpiration, into the compoſition, in exchange for an equivalent portion of the moſt volatile effluvia of the blood, exhaled from the lungs at every expiration. With this addition the blood is returned again from the lungs by the pulmonary vein into the outer of the ſecond pair of chambers of the heart, called the left auricle, where again it is agitated, or churned, and thrown into the left ventricle, where it ſuſtains a freſh commixture by the contraction of the ventricle, which paſſes it at the ſame time into the great artery, called the aorta. By theſe means the heterogeneous parts of the blood are ſo blended as to prevent the homogeneous parts from aſſociating or combining as they are apt to do, and inſtead of that they are diſpoſed to that common elaboration and influence upon each others different qualities, which renders the whole maſs fit for, and more ſuſceptible of, the various changes and ſecretions it is intended to undergo in its courſe.

Many phyſiologiſts have ſuppoſed the blood to undergo an actual fermentation, which implies a change of its nature, in the heart; but the ſtay of every portion of it there is ſo momentary, and the mechanical agitation it is there put into is ſo great, that that ſuppoſition is next to impoſſible, the animal changes not being ſo rapid as in the ebulitions of naked alkalis and acids. There is no doubt however but that agitation is intended, not only to augment the heat of the blood, which diſpoſes it to preſs outward, as all heat and bodies that move with it do, but ſo to mix the heterogeneous parts, as to prevent any combination of ſimilar parts, which might obſtruct their ſo readily yielding to the animal mutations and exaltations they are deſtined for, under the influences of the powers of life.

There is another circumſtance in the ſtate of the blood paſſing the heart unattended to, which renders the ſhocks it receives there very neceſſary, and that is the great quantity of the fluids that are in the ſtate of ſmoaking volatile effluvia, and the great tendency of all the parts of the blood, that are not combined in gluten or in red particles, to expand themſelves into that ſtate.

If the blood was not thus mixed, and theſe effluvia kept equally diſperſed among the other parts, portions of the effluvia would be apt to collect into an elaſtic maſs by itſelf, and very ſuddenly coagulate or otherways ſtop the courſe of the reſt of the blood. It is this accident, and elaſtic force of the effluvia, that ſometimes burſts the heart contracting upon it, and becomes the occaſion of the moſt ſudden of all deaths, commonly, though falſely imputed to an apoplexy.

The large quantity of fluids diſpoſed to expand into vapour is eaſily demonſtrated in the extremities of the body, by the great expanſion of the veins beyond their natural ſize, whenever the parts are expoſed to a greater than ordinary heat. On the contrary, in a ſtate of greater than ordinary coldneſs, the veins collapſe ſo much as to be ſcarcely diſcoverable.

Elaſtic vapour and air have been ſo confounded in all ages, on account of their common property of elaſticity and expanſion by heat, that it is with ſtricter propriety, or at leaſt with a more direct reference to this circumſtance, than we now apprehend, who have loſt ſight of that predominant quality in the blood, that the ancients, eſpecially regarding it, gave the name of arteries to that ſyſtem of veſſels into which the heart throws the blood; at the ſame time implying the air taken into the blood from the lungs, which it is part of the office of the arteries to ſubdue, ſo as to render it a conſtituent part or agent in the proceſs of animaliſation. The preſent philoſophy would call this, rendering the air in the blood *fixed:* But I have not ſo clear conceptions of that matter yet, as can authorize me to adopt the phraſe*.

There is one other conſideration which ſuggeſts to us a very ſtrong preſumption, if not proof, of the

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The fixed air which has become ſo faſhionable a ſubject of inveſtigation of late, ſaid to be ſo noxious in the form of air, and ſo ſalutary united again with water or other fluids, is nothing elſe than a highly volatilized and active mineral acid, in the ſtate of its firſt remove from, or laſt approach to the form of phlogiſton. In all effervеſcence, during its action, ſome of the acid particles become ſo irritated, by the impetuous neutralization of others, that they are rendered highly volatile, collect in the fluid into little parcels of ſteam incloſed in ſmall aqueous bubbles, which riſe through the liquor and break and diſcharge their effluvia on the ſurface of it. Of the ſame nature (only produced from vegetable ſubſtances) is that gas generated in and iſſuing from fermenting liquors. I remember, ſome years ago, to have ſeen a real kind of dulcified acid ſpirit diſtilled from a fermented, or rather fermenting, liquor; the ſingular taſte of which I taught the diſtiller to correct, by mixing ſome abſorbent with the ſpirit. I am perſuaded that ſuch an expedient for correcting ſuch acidents, can be no ſecret to the diſtillers by trade. If Gentlemen of a philoſophical turn would, in their reſearches, converſe more with tradeſthe large proportion of this elaſtic vapour in the blood, and that is the proportions of the cavities of the heart to the proportion of blood that can be ſuppoſed to paſs through it every pulſation. I have not the leaſt heſitation in declaring it abſolutely impoſſible, that the auricles and ventricles of the heart receive and diſcharge either one-half or one-quarter of the quantity of blood it would require to fill them, at every pulſation. The unequal ſizes of the cavities of the heart, among themſelves, is a certain proof of this. Another is the impoſſibility of even half a ton, far leſs two tons and an half, of blood paſſing through the lungs in the courſe of twenty-four hours. One principal object, therefore, of the diſproportion between the ſize

tradeſmen, they would often find ſolutions of very obſcure problems in their practices. Sir John Pringle's fair and accurate hiſtorical detail, at the conferring the Royal Society's laſt premium on Dr Prieſtly, of the ſlow progreſs made in the ſtill imperfect diſcovery of the nature of fixed air, or mephitic air, is a ſtriking proof, that there is no unlocking nature's ſecrets without a key, nor ſearching into them without a light: without theſe we may torture nature by our experiments long to little effect. Whereas the diſcovery of the proper key would ſave a great deal of that trouble, and it is often very eaſy to be found.

The fire-damp in coal mines is a highly elaſtic petroleous effluvia, burſting from deep ſeams of fatter and leſs conſolidated veins of coal, by reaſon of the want of a ſufficient reſiſtance or circulation of the common air in ſuch mines. The ſteith or mephitis is dephlogiſticated ſulphurous vapour, generated in a like manner in other mines.

The three mineral acids are the univerſal acid, diverſly modified by ſubterraneous, marine, or aerial concoction. In the form of vapour they are all ſtrongly elaſtic, and have been miſtaken, under certain circumſtances, for ſpecies of air. Each of theſe acids gives a ſpecific modification to phlogiſton; which they all either cloſely unite with, or comprehend in themſelves, as ſomehow eſſential to their conſtitutions.

ſize of the cavities of the heart, and the quantity of blood they muſt receive between every pulſation, muſt be to give room for the expanſion of the effluvia in the blood, that, by the contractions of the heart, it might be employed to divide the blood more effectually, and be mixed with every portion of it more intimately.

I ſhall conclude this diſcourſe, with a remark upon this propagation of animal life and motions by alternate action and remiſſion of action, both in the brain and heart. I will ſay nothing of the primary cauſe of it; nor will I enquire how far it is, or whether it muſt not be, if abſtractly examined, the neceſſary mode of all action. Only this we may venture to ſay, that it ſeems to be a favourite mode of ſupporting nature, both in the great world and in the little world, as the human frame is often called. The final cauſe, or the end for which it is eſtabliſhed in our frame, ſeems to be for the more effectual relief and ſupport of nature, when it languiſhes, or is in hazard of being overpowered, or the motion of the fluids ſuſpended and ſtopped by any ſudden accident; as in the caſes of great fear, horror, grief, or any extreme agony or ſtruggle of contending paſſions. When the native vigour of the ſolids, and nervous ſyſtem, in ſuch caſes, becomes relaxed, and loſes that reaction on the fluids, which is neceſſary to preſerve their motion;

then the heart throbs, palpitates, and redoubles its efforts to revive the languiſhing motions, warmth, and vigour of every part.

In ſuch caſes, it is evident, the redoubled action of the heart is not from an encreaſed quantity of fluids brought to it, but the contrary; and the immediate encreaſed acceleration of its contractions is not ſo much to fill the veſſels, which muſt be ſuppoſed fuller than before the conſtitution fell into theſe circumſtances, but to react upon the languiſhing ſolids, and reanimate their proſtrate vigour: a certain proof this, that the actions of the heart have as immediate, nay a more immediate, connection with the nervous ſyſtem, the ſecretories of life, than with the immediate motion of the fluids as a mechanical cauſe thereof.

In ſhort, the reſpective powers and compounded influences of the brain and the heart upon the human frame, may, with great propriety, be compared to the agency of the ſun and moon upon the great world. The ſun pervades all nature, and ſheds his influences in its moſt intricate receſſes, elaborating out of one whole, according to its various circumſtances, and aſſortments, an infinite variety of properties and forms: while the moon, by a ſpecial regulation and flexion of his influences, diſpoſes that great maſs of fluids, which are the immediate organs of his energy, and the ſubject of all his operations and productions, into theſe tides and reciprocations of ebbing and flowing, which is, according to the conſtitution of things, ſo neceſſarily ſubſervient to their being conveyed in a proper diſpoſition, into all theſe elaboratories into which the ſun, from whom nothing is hid, reaches.

Juſt ſo in the microcoſm, the brain, by the mediation and irradiation of its nerves, penetrates and animates every point of our frame, and particle of our compoſition, diſpoſing every fluid particle to a ſpontaneous motion and accommodation of its nature to the character and ſtructure of the parts to which it attinges; while the heart, by its reiterated impreſſions and ſhocks on both the ſolids and fluids of our ſyſtem, gives an additional vigour to the animation and diſpoſitions of the whole, and cauſes theſe perpetual colliſions which irritate and invigorate the living flame that is glowing in every part.

I cannot, Gentlemen, take upon me to warrant the infallibility of every thought or ſuggeſtion I have riſked in this lecture, and the compaſs it reſtricts me to, has debarred me from further enlargement upon any of them. Several of theſe may be allowed to be problematical, without the main queſtions being affected thereby; but I perſuade myſelf that I have proved, both my general propoſition, and the ſeven inferior ones, under which, for the greater clearneſs and diſtinctneſs, I have diſtributed the evidence.——I have offered the whole to you alſo, with the greater aſſurance, having firſt ſubjected it to the examination and caſtigations of a perſon, the clearneſs of whoſe underſtanding on theſe ſubjects, as well as his impartiality, I have a very high opinion of*.

If any perſon ſhould be diſpoſed to derogate from the importance of the diſcovery, as of little conſequence to the practice of medicine; there is one ſhort and ſilencing anſwer to ſuch detractors, which every Gentleman of the faculty preſent will ſee the concluſiveneſs of†. If the diſcovery of the circulation was received with the greateſt applauſe over all Europe, as of the greateſt conſequence to medicine, certainly the knowledge of the cauſes of the circulation muſt be of equal importance. The

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* I mean my friend Dr Hall, of Newcaſtle, diſtinguiſhed for the quickneſs of his parts, and the livelineſs of his apprehenſion, by all who know him; and yet who, in his practice, examines the complaints and ſymptoms of his patients diſorders, as minutely as the ſloweſt and moſt deliberate genius can do. It were to be wiſhed, that people of vaſtly inferior capacities would adopt ſo good and ſo prudent an example of circumſpectneſs.

† I ſhould not have inſerted this remark, calculated only to obviate private detraction, in the publication, which is an appeal to the public candor, but that I was adviſed, by the Gentleman mentioned in the laſt note, to print the lecture juſt as it was delivered, that it might appear juſt what it was, not a finiſhed treatiſe on the ſubject, but ſuch a ſurvey of it, as ſuited the audience, and could be comprehended in the compaſs of a lecture. I hope this will ſufficiently apologize for any thing elſe in the diſcourſe that may appear to be local, and to have little connection with the ſubject itſelf.

queſtion then only is, How far we have attained that diſcovery in the preceding diſſertation? If any of the Gentlemen, my hearers, are deſirous of entering into converſation upon that ſubject, I will be proud of an opportunity of joining them in it, when and where it ſhall be agreeable to them to appoint.

GENTLEMEN, I return you thanks for your company and attention during this tedious diſcourſe, which I really could not abridge further, without injuring the diſtinctneſs I have aimed at preſerving in it.

POSTSCRIPT.

THE theory and the practice of medicine are ſo intimately connected with each other, and ſo reciprocally dependent on one another, that the ſoul or the body might with as much propriety ſay the one to the other—I have no need of you—as any practitioner in phyſic can ſay, I have no uſe for theory to direct my practice. Libertines can ſee no excellency in religion: Fools feel no deficiency from their want of wiſdom: And ignorant perſons can perceive no neceſſity for the drudgery of ſearching for knowledge. There is not one point of knowledge, either known or attainable, that does not as neceſſarily imply a practical inference, as a cauſe does an effect, or as the major and minor of a ſyllogiſm do a conſequence. Truth of every kind is a connected ſeries, a chain of many links, and a ladder of many ſteps; which, though you cannot perceive the ſummit of, yet every ſtep you advance leads you to another, and renders it acceſſible to you.

It muſt certainly be for ſome very wiſe reaſon, that the Author of Nature has in ſo many inſtances rendered effects ſo ſenſible and obvious, while their cauſes are latent and veiled. It cannot be deſigned to prompt men to reſt in appearances, and carry their proſpects no further. I ſhould rather apprehend that this plan of things was meant to inculcate upon our underſtandings, that while ſenſible things were abundantly furniſhed out for the ſecurity and felicity of our lives, inſenſible things were propoſed for the exerciſe and improvement of our rational faculties: That we might, if we pleaſed, diſtinguiſh ourſelves as much as poſſible from the brute creation, who are neceſſarily limited to the narrow circle of ſenſe and inſtinct.

I would not wonder much, if, notwithſtanding my caveat, ſome perſons ſhould ſtill ſay, and even really think, that whatever probability or truth there is in the above doctrine, it can have little connection with or influence upon practice.—If ſuch a ſurmiſe is groundleſs, I am really bound to aſk pardon of the public for ſuggeſting it; for I own, it is but an ill-favoured imputation upon the underſtanding of any perſon profeſſing the practice of medicine, to ſuppoſe him capable of imagining a diſtinct knowledge of the active principles of our conſtitution can have little or no connection with the cure of diſeaſes; all which are no more than a viciated ſtate of theſe powers, or ſome oppreſſive load or obſtruction upon one or other of them, manifeſting itſelf by proper ſymptoms either univerſally or topically.

If there is any juſtice in the doctrine contained in the above diſcourſe, it ſuggeſts a new and uſeful method of arranging diſeaſes. I do not mean that it ſuperſedes other arrangements already known: But certainly, the greater variety of views we can take of objects which have any intricacy or obſcurity in them, and the more different lights we can place them in, we have the better chance of knowing them more diſtinctly.

The method of claſſing diſeaſes that I allude to, is diſeaſes ariſing from arterial obſtruction; diſeaſes depending upon any defect of venous abſorption; ſuch diſeaſes as more immediately refer to the ſtate of what I have called the vital principle, than to either of the former; and diſeaſes that ariſe from ſome error in the concoction or animalization of the fluids. Indeed all the powers acting in our frame are ſo interwoven into one piece, and each is ſo neceſſary every where, that no one can be ſaid to be affected by itſelf: Yet as every diſeaſe muſt originate ſomewhere, ſome one part of the ſyſtem muſt be more originally, more immediately, and more principally affected than another.

Wherever diſeaſes become divided into new claſſes, or are ſuſceptible of a new diſtribution, medicines of courſe fall into the ſame line of diſtinctions; ſeeing the intentions of cure muſt always, or at leaſt ought always, to ſuggeſt the means or medicines appropriated for effecting it. The new claſſing of diſeaſes is alſo of great conſequence in ſuggeſting new intentions of cure, and conſequently new means and expedients for attaining that end.

The above doctrine, if well grounded, ought to reform the doctrine of the pulſe in a great meaſure; which, according to it, is to be conſidered as the reſult, and not the cauſe, of the diſeaſes by which it is affected.

But in no caſe can this doctrine, ſo far as it may be depended upon, be more uſeful, than in enabling practitioners more clearly to diſtinguiſh between real diſeaſes, and theſe ſalutary ſymptoms of the inherent ſtrength of many conſtitutions; which ſubdue and purge off the vices that have inſinuated themſelves into them. The miſtaking of theſe, for real diſeaſes, is, to the ſhame of many practitioners, the annual ruin of hundreds.

I cannot give a more ſtriking example of this than in the caſe of the itch. That it is an infectious diſeaſe, often though not always, there is no doubt. That it is alſo a diſeaſe that may often be prevented by cleanlineſs, &c. is very certain; and that it may, under certain circumſtances, be ſafely cured by live ſulphur, is true alſo.

At the ſame time it is no leſs certain, that it is not a diſeaſe cauſed by animalcula, of which ſulphur is the poiſon; that it is the true aſſeſcent ſcurvy; that it is an endemic in mountainous moiſt countries, where they feed almoſt ſolely upon oaten bread, and where it is ſo preſerves from other diſeaſes; that it comes often without infection; that there are ſeveral ſpecies of it, and degrees of malignity in it, and that hundreds are annually murdered by its being treated with ſulphur externally only. It is truly melancholy to reflect upon the ignorance and ſelf-ſufficiency of many practitioners, who, with an air of importance and ſagacity, will inſtantaneouſly decide upon all theſe points, by inſpecting the wrinkles between a man's fingers, who has the itch. How many conſumptions, one of the opprobria medicorum, might have been prevented by not repelling that diſeaſe! and how many, that are otherwiſe incurable, might be cured by recalling it, if poſſible, after the ſeat of the diſeaſe is ſo tranſlated.

I cannot blame this age in general, whatever imputations may reſt ſtill upon particular places, for want of a ſpirit of enquiry; it was to excite it in this place that was the intention of compoſing this lecture: I ſhall be very glad if the ſucceſs anſwer my intention.

But there is one thing I would beg with ſubmiſſion to obſerve upon the preſent biaſs to experiments. I am no enemy to them, but it is not ſafe for thoſe who have not made them, or ſeen them made, either to reaſon from them, or to truſt to the reaſoning of others upon them. We have ſeen not only different reſults of experiments reported, but different concluſions drawn from them. As ſcarcely two men can make an experiment, either with exactly the ſame intention, or with the ſame attention to circumſtances, or as ſcarce one can make an experiment with attention to all circumſtances; one's obſervation being engroſſed by one thing, and another's by another.

Beſides, how often are experiments inſtituted to diſcover, explain, or illuſtrate the nature of operations they have not the leaſt relation to, in their ſituations and circumſtances. What connection, for example, can there be between two liquors, allow them to be individually the ſame; the one committed to its own ferment and inteſtine mutations, in a capacious veſſel communicating with the common air, whoſe unexplained agency is ſo neceſſary to the inverſions and generations of all unorganized mixed liquors: What relation, I ſay, can there be between this ſtate of a liquor, and even the very ſame, excluded from all acceſs of more air than is mixed in it, conſtantly exhaling into veſſels, and moving progreſſively in them, the diameter of whoſe orifices may not be the thouſandth part of an inch, and conſtantly irradiated upon by powers that can concoct or change its nature, character, conſiſtency, nay even its colour at pleaſure, ſo to ſpeak, in a moment. So that learning in general is often not ſo much profited or advanced by this mode of philoſophiſing, as is ſuppoſed or might be expected.

Obſervation, attention, and cloſe extenſive reaſoning, I think not only a ſafer tract, but a more promiſing courſe for the advancement of knowledge. Nature furniſhes facts equivalent to all the experiments that can be made; and a cloſe and accurate inquiſition, by induction from her powers, and the products of them, without previous hypotheſis or aſſumed principles, promiſes fair to carry one's views fartheſt. The philoſophy that aſſumes one principle that is not an uncontrovertible fact, muſt in the end infallibly entail upon our minds a train of ill-digeſted (however plauſible) conjectures; which, adopted by perſons who comprehend what other people ſay, but who cannot think for themſelves, or walk but in leading-ſtrings, will form into inveterate prejudices againſt whatever they have not learned, or whatever does not tally with what they have been taught. So that frequently, when people think they are promoting knowledge, they are actually raiſing ramparts againſt its progreſs.

F I N I S.

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